Experimental report

In the last years, carrier transport and magnetotransport mechanisms in nanostructured thin films have been at the focus of interest because of their great application potential in magnetic memories, spintronics, etc. In this context, metal/semiconductor structures such as those formed by a magnetic thin film deposited onto a silicon substrate are very common. Specifically, in previous works a switching of conducting channel and magnetoresistance (MR) has been observed and associated to: the presence of an inversion layer in the Si substrate (highly conducting region next to the native SiO2 layer), which could provide a low resistive path for electron transport [1]-[3], the formation of a silicide at the same interface [4], or the diffusion of metal ions into the Si, originating an interface layer that allows a thermal dependant carrier transport from the metallic film to the substrate [5], [6]. In our case, we have found a similar anomalous thermal evolution of the resistivity, showing a dramatic drop in the range 200 < T < 300 K. This resistance transition is completely reversible with temperature and independent of the applied magnetic field and has been associated to the nature of the Si substrate employed during deposition and to the presence of a native oxide layer. Previous XANES studies carried out at spring-8 on a pulsed laser deposited (PLD) FeAg thin film, wich showed such a drop of the resistivity, revealed a an increase of the main absorption peak (at 20 eV above the edge) and a decrease of the shoulder like structure (at the edge) which were initally related to the electronic nature of the transition.

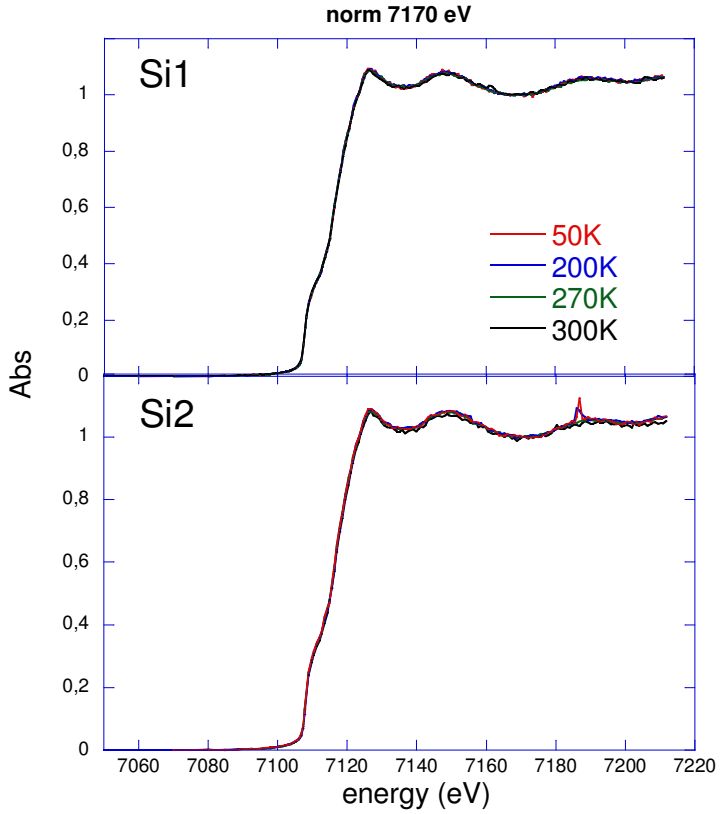

Figure 1. Fe K-edge XANES spectra of the $Fe_{43}Ag_{57}$ thin films deposited onto Si1 and Si2

In this experiment, XANES measurements were performed in two PLD FeAg thin films prepared simultaneously onto two Si substrates with low (Si1, ρ = 0.015 Ω-cm) and high resistivity (Si2, ρ = 7-25 Ω-cm). Despite both samples having a very similar magnetic behaviour, only the one prepared onto Si1 presented a transition of the resistivity. Therefore, what we pretended with this analysis was to compare the spectras obtained for both samples measured at the Fe K-edge in order to acquire a better understanding of the phenomena previously observed at Spring-8 and to check if they were associated to the intrinsic nature of the PLD thin films or if they had to do with the presence or not of the transition, and therefore, with the nature of their Si substrates. The data were collected at BM25A (Spline) beamline. During the available beamtime, we were able to perform a complete XANES analysis at four different temperatures: 50, 200, 270 and 300 K. We always collected the data at least 8 times in order to obtain better statistics and to reduce the noise appearing in the spectra. The normalized XANES spectra of both samples showed very similar behaviour and no appreciable changes were observed as a function of temperature. It is true that depending on the normalization very slight changes may appear, but nothing similar to the ones previously observed at Spring-8, which encourages a further study.

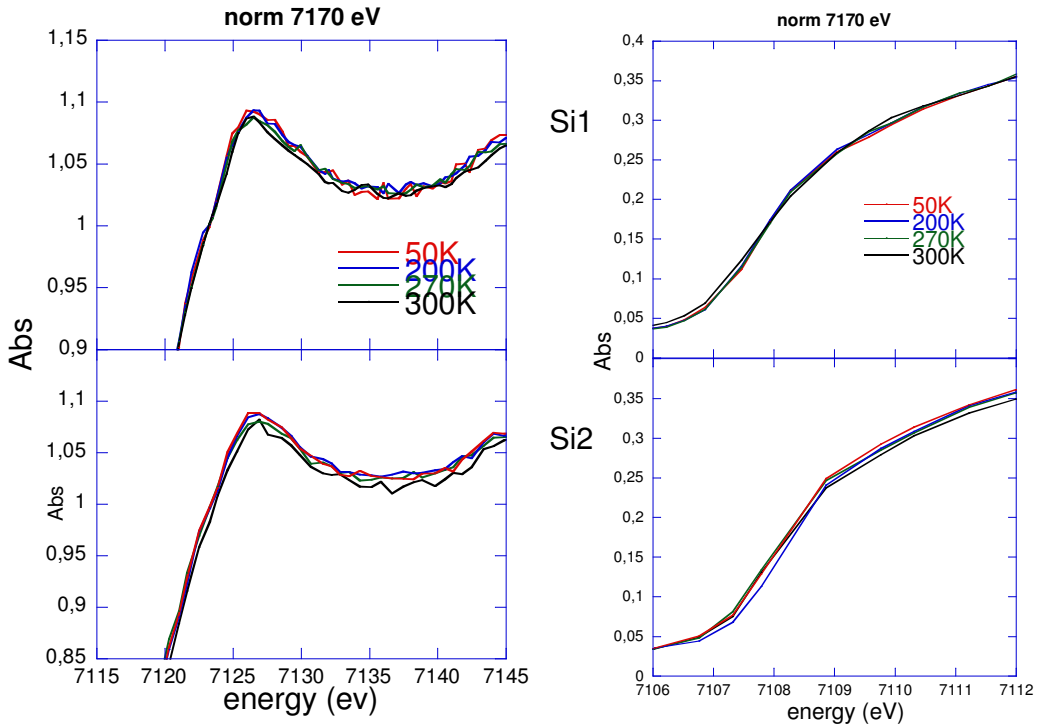

Figure 2. Fe K-edge XANES spectra of the $Fe_{43}Ag_{57}$ thin films deposited onto Si1 and Si2 (*left*) detail of the main absorption peak, (*right*) detail of the shoulder like structure near edge

Finally, we would like to thank the SPline team for competent support and help all through our experiments and before and after our arrival to the ESRF, as well as the personnel at the facility for their assist in all the aspects of their competence.

[1] J. Dai, L. Spinu, K-Y Wang, L. Malkinski and J. Tang, “Channel switching and magnetoresistance of a metal-SiO2-Si structure”, *J. Phys. D: Appl. Phys.*, vol. 33, L65, January 2000.
[2] J. Tang, J. Dai, K. Wang, W. Zhou, N. Ruzycki and U. Diebold, “Current-controlled channel switching and magnetoresistance in an Fe3C island film supported on a Si substrate”, *J. Appl. Phys*., vol. 91, No. 10, pp. 8411-8413, May 2002.
[3] H. B. de Carvalho, M.J.S.P. Brasil, J.C. Denardin and M. Knobel “Transport and magnetotransport transition of thin Co films grown on Si”, *Phys. stat. sol.* (*a*), vol. 201, No. 10, pp. 2361-2365, August 2004.
[4] M.F. Li and K.H. Wong. “Giant positive magnetoresistance of Ti/Si based films prepared by pulsed laser deposition”, *J. Magn. Magn. Mater.,* vol. 196-197, pp. 31-32, May 1999.
[5] S. Witanachchi, H. Abou Mourad and P. Mukherjee. “Anomalous metal-insulator transition in FeSi films deposited on SiO2/Si substrates”. *J. Appl. Phys*. vol. 99, pp. 07310-1, April 2006.
[6] S. Witanachchi, H. Abou Mourad, H. Srikanth and P. Mukherjee. “Anomalous conductivity and positive magnetoresistance in FeSi-Si O2- Si structures in the vicinity of a resistive transition”. *Appl. Phys. Letters* vol. 90, pp. 052102-1, January 2007.